Humidity cell analysis of waste-rock from the Diavik Diamond Mine, NWT, Canada

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Acid rock drainage can significantly effect the environment surrounding mine sites. The potential for acid rock drainage can be predicted with the use of kinetic tests such as humidity cells that represent ideal experimental conditions. Humidity cell analysis was conducted on twelve samples of sulfur-bearing waste rock from the Diavik Diamond Mine, based on the flood leach method of the ASTM Standard D 5744 [1]. Samples were characterized and subjected to controlled dissolution testing for 455 days to 665 days (65 – 95 weeks). Four samples of each type of waste-rock was placed into humidity cells. Waste-rock on-site is segregated into three classifications based on low to high sulfur content; Type I is a clean granititc material with a sulfur content less then 0.04 wt.%, Type II has a sulfur content between 0.04 and 0.08 wt.%, while Type III is a biotite shcist with a sulfur-content greater then 0.8 wt%. Weekly leachates from the humidity cell were collected and analyzed immediately for pH, Eh, conductivity and alkalinity. Samples were filtered, and the leachate analyzed to determine the concentrations of anions, nutrients and cations.

Effluent pH varies depending on the waste-rock type. The most significant decline in pH occurs in two samples of type III had a pH that dropped to 3.9 – 4.0 from 6.4 in 57 – 63 weeks. At the same time some concentrations have increased, such as; Al, Cu, Fe, Ni, Zn and SO_4. The remaining two samples of Type III show a significantly different pH trend, a range of pH of 6.8 – 8.3 over the duration of the test. The range of pH for types I and II is less dramatic with a gradual decline of 1 – 1.5 pH units. Analysis of the leachate chemistry from the humidity cells tests are used to determine the rates of sulfide oxidation, which will be compared to rates measured on the large-scale waste rock piles.

[1] ASTM Standard D 5744, 1996 (2001) “Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell,” ASTM International, West Conshohocken, PA, www.astm.org.

Origin and geochemical evolution of mafic magmas from the Cascade arc, Mount Baker, Washington: Probes into mantle processes

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Mt. Baker is an active stratovolcano in the Garibaldi Belt of the Cascade arc in northern Washington. The composition of this volcanic field is largely andesitic, with basalt comprising only ~1% of the total eruptive components. Heretofore, knowledge of the geochemistry of the mafic flows on Mt. Baker has been restricted to major elements of a very limited number of samples. Whole rock chemistry reveals the diversity between these mafic lavas, which must be derived from distinct sources.

Five mafic lava flows have been sampled and analyzed for major, trace and REE chemistry: the basalts of Park Butte (49.3-50.3 wt.% SiO_2, 7.9-8.4 wt.% MgO), Lake Shannon (50.7-52.6 wt.% SiO_2, 5.3-6.4 wt.% MgO), and Sulphur Creek (51.2-54.6 wt.% SiO_2, 5.0-5.5 wt.% MgO), and the basaltic andesites of Tarn Plateau (51.8-53.9 wt.% SiO_2, 7.0-7.9 wt.% MgO), and Cathedral Crag (52.1-52.9 wt.% SiO_2, 3.8-8.3 wt.% MgO). The Tarn Plateau basaltic andesite and Park Butte basalt flows are the most primitive, with Mg# ($100[Mg/(Mg + Fe^T)]$) ranging from 60 to 67, Ni content from 59 to 67 ppm, and Cr content from 176 to 267 ppm. Mg# is not correlated with SiO_2 content, as the Tarn Plateau basaltic andesite has the highest Mg# of all the lavas. The Park Butte flow is classified as low-K tholeiitic basalt (compositionally similar to LKOT found elsewhere in the Cascade arc), while the remainder of the flows are classified as medium-K calc-alkaline basalts and basaltic andesites.

The REE patterns differ from flow to flow, with varying slopes. Park Butte (LKOT) has the flattest REE pattern and the lowest abundances of REE of all the lavas, with $(La/Sm)_N$ at ~1.7 and $(LREE)_N$ values from 25-35. Tarn Plateau has a relatively steep REE pattern, with $(La/Sm)_N$ at ~2.2 and $(LREE)_N$ values from 40-55. However, the most differentiated lava (Cathedral Crag) has the steepest REE pattern, with $(La/Sm)_N$ at ~2.3 and $(LREE)_N$ values from 45-70. Ba, Sr and Th cannot be correlated between the most primitive flows (Tarn Plateau and Park Butte), demonstrating that these lavas are not genetically related. We describe multiple mantle sources that generate mafic magmas of such varied compositions.